

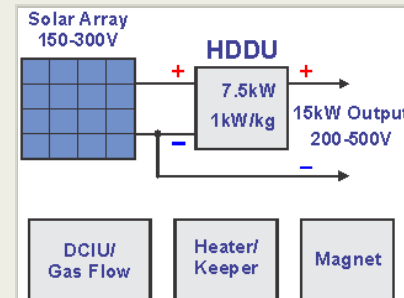
Hybrid Direct Drive PPU with Extended Operating Range, Phase II

Completed Technology Project (2013 - 2015)



Project Introduction

High-power electric propulsion with Hall thrusters has been proposed as a strong candidate for Electric Path missions, but conventional power processing units (PPUs) are complicated and the mass of the discharge power converters needs to be reduced. Direct Discharge Power Processing Units (DDUs) have been proposed as an alternative due to their simplicity and low mass, but the achievable operating range of thrust and ISP is significantly limited because power regulation for DDUs is only achieved through gas flow control, array offpointing or shunting. This proposal presents a compromise between PPUs and DDUs called a Hybrid Direct Drive Power Processing Unit (HDDU) that provides a wider operating range than DDUs while reducing the mass and increasing the efficiency compared to conventional PPUs. An HDDU provides filtering like a DDU, but it can additionally raise or lower the discharge voltage over a limited range. An HDDU only processes the power necessary to raise or lower the discharge voltage. We propose using a soft switching non-inverting interleaved buck-boost circuit similar to what was built for Phase I, but with improved control circuitry and a modular chassis. Straight-through direct drive operation is possible by leaving the buck switches on continually while having the boost switches off. The proposed HDDU would operate from an input voltage of 150 V to 300 V, and would provide 15 kW output power from approximately 200 V to 500 V. The HDDU approach is readily scalable to higher power levels by connecting modules in parallel because the proposed circuit naturally shares output currents. The HDDU will also include a digital control interface unit (DCIU), heater, keeper and magnet supply modules and driving circuits for a VACCO gas flow controller. The DCIU will be controlled through a Windows GUI and a MIL-STD-1553 communication to USB adapter. The modular approach and enhanced operating range promote design re-use and reduce life-cycle costs.



Hybrid Direct Drive PPU with Extended Operating Range Project Image

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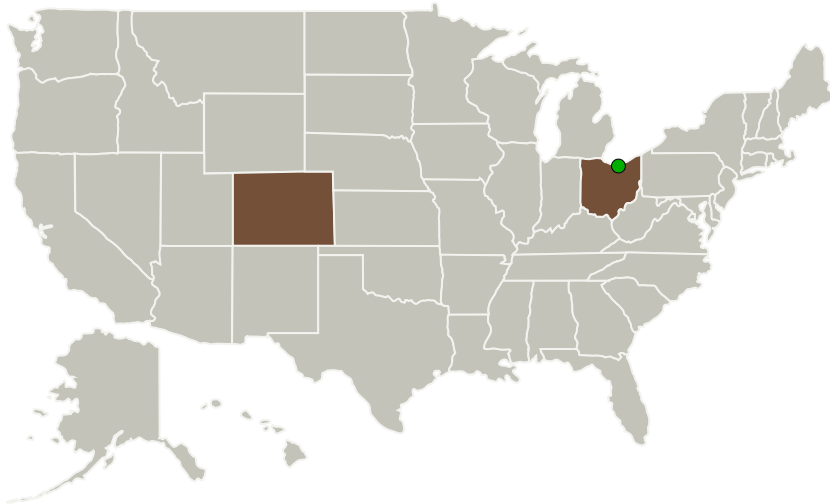
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Primary U.S. Work Locations and Key Partners





Organizations Performing Work	Role	Type	Location
Colorado Power Electronics, Inc.	Lead Organization	Industry Veteran-Owned Small Business (VOSB)	Fort Collins, Colorado
● Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations

Colorado	Ohio
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Project Transitions

 **January 2013:** Project Start **May 2015:** Closed out

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Colorado Power Electronics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Bryce L Hesterman

Co-Investigator:

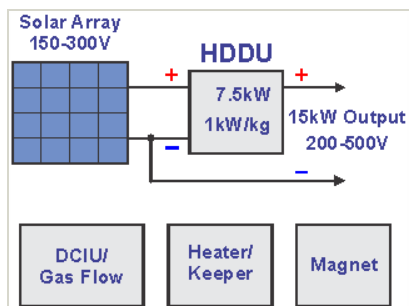
Bryce Hesterman

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Images



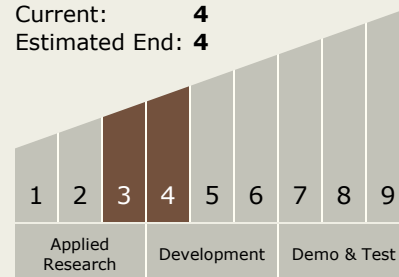
Project Image

Hybrid Direct Drive PPU with
Extended Operating Range Project
Image

(<https://techport.nasa.gov/image/130150>)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
 - └ TX01.2 Electric Space Propulsion
 - └ TX01.2.2 Electrostatic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System